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ABSTRACT

A kindergarten teacher reviews research findings on aspects of children's diet that may influence behavior and the ability to learn. Introductory discussion presents vignettes relating kindergarten children's behavioral responses to dietary intake. A brief background section offering dietary tips is followed by relatively extended discussions of caffeine, sugar, food additives, food allergies, and general nutrition. The section on caffeine emphasizes Baer's (1987) naturalistic study of the responses of individual children to caffeine. The study found only a few weak relationships between caffeine ingestion and outcome variables. The discussion of sugar's effects focuses on carbohydrate sensitivity and hyperactivity. The section on food additives focuses on Dr. Feingold's research, the effectiveness of the Kaiser-Permanente (K-P) Diet, as well as studies showing no consistent deterioration in children's behavior following dietary challenges with artificial food coloring. Discussion of food allergies takes into account the summation effect, exemplified by a child who has symptoms from eating chocolate only during ragweed season. Concluding remarks briefly consider problems related to inadequate nutrition, skipping breakfast, iron and protein deficiency, sugar excess, and chronic hunger. (RH)

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Effects of Food Products on Behavior, Learning Abilities, and Social Relationships in Preschool and Elementary School Children

by
Cecilia N. Crews

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Effects of Food Products on Behavior, Learning Abilities, and Social Relationships in Preschool and Elementary School Children

Introduction

Food products in the diets of children can have an effect on their behavior. As a kindergarten teacher, I have observed some inappropriate behavior in students. Their behavior, I suspect, was food related. The children discussed in the following paragraphs were between five and six years of age when they were in my classroom. The names of the children have been changed.

Eddie was a very active, talkative child. He had trouble sitting still, listening to stories, and doing his handwriting papers. His pediatrician had suggested that he could possibly be hyperactive but he was not on any medication. Our kindergarten children are given white milk with their snacks. One day Eddie was the last child in line for snack. There was no white milk left, and he had to have chocolate milk. I could only imagine how the chocolate milk would affect an already very active child. I could see him "climbing the walls." About 30 minutes after snack I noticed Eddie was calm and playing quietly with the other children at his table during center time. After this incident, my aide made sure that Eddie occasionally received chocolate milk. The results were always the same. About 30 minutes after snack Eddie was able to play with his peers.

Teddy was a bright, well-behaved kindergarten student who got along well with his classmates. I noticed that Teddy was inattentive and crabby one day. After this behavior had continued a few days, I discussed the problem with his mother. She, too, had noticed the change in her son. She decided the problem could be caused by a reaction to dairy products, processed cheese in particular. Teddy's mother limited his intake of dairy products. She did not take dairy products away completely, she reduced the quantity he was given. Processed cheese was taken away totally. Teddy's behavior returned to normal and was fine as long as his intake of dairy products was monitored. Several weeks later the unacceptable behavior returned. I spoke with Teddy's mother again and learned that he had eaten some processed cheese.

Andy was a talkative, fidgety, very active child. He could not sit still during story time, participate in singing songs, or doing fingerplays, nor could he concentrate during teacher directed handwriting practice. Andy was never quiet, never still. He was in motion constantly. His mother offered no suggestions as what might help Andy calm down. She did not seem very interested in helping her son. Andy continued to miss playtime as a result of his behavior. Neither talking with him nor trying to reason with him helped. Missing playtime did not seem to bother Andy either. He played at his seat by himself. It was not until March,

when studying nutrition, did I learn that Andy had coffee every morning for breakfast. He frequently had pancakes with syrup or biscuits and jelly with his coffee. I do not know if the foods and coffee he had for breakfast affected his behavior or not. Andy was the smallest child in his class. I think the amount of caffeine in the coffee he drank in combination with sugar was too much for his small body. I think that it over-stimulated him. The combination of caffeine and sugar would probably have little, if any, effect on his parents if they consumed the same amount.

Jenny was a model student. She was bright, well-behaved, and got along well with her classmates. One day she was very talkative and restless. I could tell that she was struggling to listen to the story and to do her handwriting paper. There was definitely something different about Jenny's behavior that particular day. She was in the afternoon class and had lunch just before coming to school. I asked her what she had eaten for lunch. She replied, "Beanie Weanies, bread, . . . and chocolate pudding." I asked her if she usually had chocolate pudding for lunch. She said that she usually had fruit or vanilla ice cream. I credited the chocolate pudding with Jenny's behavior that particular day.

Jill was an "allergic" child. She had skin allergies and respiratory allergies. She was usually quiet and well behaved.

Jill would occasionally have days when she would giggle uncontrollably. There was no explanation as to why she had the "giggles." Her mother and I discussed the problem. Both of us had the opinion that Jill might be allergic to certain foods. Jill went to a doctor concerning the possibility of food allergies. She was diagnosed as having allergies to many foods. She had to take oral medication frequently for the respiratory allergies. The medications she took probably contained artificial flavors and colors. The medication and the foods Jill was allergic to could have caused the out-bursts of giggling.

My daughter, Suzy, could not tolerate chocolate until she was about nine years of age. One Oreo cookie would give her diarrhea and keep her from resting or playing quietly when she was two years of age. Her tolerance for chocolate increased as she grew and got older. Suzy had a lot of ear and respiratory infections requiring prescription medication. One particular medication she was prescribed "sent her into orbit." It was an antihistamine and should have made her drowsy. The medication was purple and grape-flavored.

These are a few isolated instances which I have observed. I have no proof whether the foods caused the unusual behavior or not. In each instance, though, caffeine, sugar, food allergies, food additives, or a combination was involved. The medications are not food products, but they are ingested as foods are.

Background Information

"You are what you eat!" is a cliche that has been quoted many times. It simply means that a person must eat foods that are nutritious in order to be healthy. This cliche is usually directed to adults but it applies to children as well. It is imperative for children to eat healthy, nutritious foods. Children are growing physically, emotionally, mentally, and socially. The eating patterns that children develop at this age are the eating patterns that they will maintain throughout their lives. Children should be introduced to a wide variety of foods when they are very young so that they will develop a taste for many different foods.

A well-balanced diet consists of foods from each of the four basic food groups. The meat and potatoes diet has become obsolete. This does not mean that meat and potatoes should be eliminated from the diet completely, but added to. Vegetables such as broccoli, cauliflower, and spinach are excellent sources of fiber and nutrients. These vegetables may be served raw as well as cooked. They are low in calories, also.

Chicken, turkey, or fish may be served as an alternative to beef and pork. Chicken, turkey, and fish may be prepared in a variety of ways. They are lower in calories and cholesterol than beef and pork. Quiche may occasionally be served as an alternative to meat. Eggs are relatively high in cholesterol, a fact which should be

considered when serving quiche. Dried beans and peas, which are good sources of protein, may be added to homemade soups, or served in addition to a variety of vegetables for a meal without meat. Peanut butter, which is usually a favorite food of children, is delicious when mixed with puréed fruit, a small amount of fruit juice, or honey instead of jelly. The fruits and honey are naturally sweet and do not have the added refined sugar that jelly does.

Most children like sweets. Fresh fruits, when in season, or canned fruits that have been packed in their natural juices may satisfy the desire for something sweet. Candies, cakes, and cookies prepared at home may be made with less sugar than the recipes call for.

Breakfast has been called the most important meal of the day. It is probably the most hurried meal of the day. Many children go to school without breakfast for one reason or another. The most popular reason for children not eating breakfast is probably the lack of time. Children should eat breakfast before going to school. It is the responsibility of their parents or caregivers to get children out of bed in time to eat breakfast. The traditional large breakfast consisting of bacon, eggs, toast, fruit juice, and milk does not need to be, and should not be served every day. Saturday may be the special day for the traditional breakfast. Cooked or unsugared dry cereals are good for a quick school-day breakfast. Peanut

butter and cheese toast are quick, easy to prepare, and tasty for the children.

The relationship between the foods children eat and their behavior has come under close scrutiny in the past years. Caffeine, sugar, food additives, and food allergies are being considered as factors in hyperkinesis in some children. Dr. Benjamin Feingold (1975) began to study how food products can affect the behavior of children. This was not the first of such studies, however. As early as the 1920's studies were being done on the relationship of food products and behavior (Barkley, 1987).

Caffeine

Caffeine is probably the world's most popular drug. It is a white crystalline substance first isolated from coffee in 1820. Caffeine is found in coffee beans, tea leaves, cocoa leaves, hence in chocolate products, and kola nuts. The caffeine content of chocolate products depends on the origin of the cocoa. Cocoa grown in Africa typically contains 0.3% caffeine; cocoa grown in South America may contain as much as 1.7% caffeine (Gilbert, 1981).

Substantial amounts of caffeine can be ingested from cola drinks, which contain about 30 mg per 250-ml (9 oz.) serving, half of the caffeine coming from the kola-nut base and half being added. A cup of hot chocolate or cocoa may contain as much as 40 mg caffeine, but usually contains less. The standard 30-gram chocolate bar has

about 20 mg caffeine. The average caffeine content of a cup of brewed tea has been found to be 27 mg (Gilbert, 1981).

Caffeine taken orally in beverage form reaches all of the body tissues within five minutes. Peak blood levels of caffeine are reached in about 30 minutes. On the average, half of the caffeine in a given dose is metabolized in four hours. Slower metabolism produces a potentially greater caffeine effect per unit dose because the drug stays unchanged in the body. Normally almost all ingested caffeine is metabolized; little can be recovered in urine and there is no day-to-day accumulation in the body (Gilbert,1981).

Caffeine is a behavioral stimulant. According to Royster (1983), caffeine . . . does not affect all people in the same way. If consumed in large enough doses, it can cause insomnia, nervousness, irritability, anxiety, and disturbances in the heart rate and rhythm. It also seems to have an effect on coronary circulation, blood pressure, the diameter of the blood vessels, and the secretion of gastric acids. Caffeine can also act as a diuretic on the kidneys.

Gilbert (1981) states that there have been reports that consumption of caffeine beverages may be beneficial in the treatment of hyperkinetic children as a substitute for the more potent stimulants that are more commonly administered, but the evidence is contradictory. The reports were stimulated by reports that childhood hyperkinesis may not exist in Latin American countries, where children drink coffee

from an early age, and by suggestions that early coffee drinking may be unwitting self-medication for hyperkinetic symptoms.

Ruth A. Baer (1987) performed a study to determine the effects caffeine had on preschool children. Previous research on this topic has shown that many American children consume enough caffeine per day to cause central nervous system stimulation. Recent research suggests that caffeine may exert some behavioral effects on children, but findings are unclear because of methodological problems. First, measures have usually been administered only once per condition (caffeine vs no caffeine). Thus the extent of intrasubject variability within conditions (e.g. the development of tolerance) is unknown. Second, no direct behavioral observations have been made. Instead, global ratings of qualities such as "fidgetiness" have been used. Third, most measures have been administered in laboratory settings unfamiliar to the children, with an unfamiliar experimenter using unfamiliar materials. This makes it difficult to draw conclusions about the effects of caffeine on children's typical behavior in their natural settings. Fourth, most studies have administered the caffeine in combination with sugar, making it difficult to draw conclusions about the effects of caffeine alone. Fifth, all studies have used large groups of children and averaged the data across groups. Analyses of the responses of individual children have never been conducted, precluding detection of individual variability.

Sixth, these studies have used doses of caffeine that, although consistent with reported daily caffeine consumption in many children, are much larger than the average child could consume in a single serving in reality.

The study was designed to overcome the problems in previous studies. The study was done in the children's natural setting. Caffeine was not administered with sugar. The amount of caffeine administered was consistent with the amount a child would consume in a normal situation.

Six 5-year-old children (4 boys, 2 girls) who attended a kindergarten and day-care center in Lexington, Kentucky, were the subjects. All were developmentally and behaviorally normal. All procedures were conducted at the day-care center. Direct observations of the children's behavior were conducted in the regular classroom while the children were engaged in their normal activities. Normal activities included both free play and structured activities such as completing worksheets, art projects, or listening to a story. Additional measures were administered in a separate, quiet room at the cay-care center (Baer, 1987).

The following is a description of the dependent measures and procedures:

Off-task. Off-task was defined as any behavior that violated a classroom rule. Off-task was measured by observers using a 10-second (s) observe, 5-s record interval system. If any off-task behaviors were

observed during an interval, that interval was scored off-task.

Gross motor activity. Prior to baseline, strips of electrician's tape were placed on the floor of the classroom to form a grid of squares measuring 67.5 cm by 67.5 cm. Gross motor activity was defined as the number of grid crossings (squares in which the child placed at least one foot) during each 10-s interval and was measured during free play. Observers recorded grid crossings and off-task behaviors simultaneously.

Actometer readings. An actometer is a self-winding wristwatch modified so that movements cause the hands to advance rapidly. Each child wore an actometer on the dominant hand and ankle, during each free play and structured activity period in which he or she was being observed. Observers noted the actometer readings before and after each child was observed. The numbers of hours that the hands had advanced then was summed across ankle and wrist actometers.

Continuous Performance Test (CPT). This test is a widely accepted measure of sustained attention/vigilance and of impulsivity. It has been shown to differentiate hyperactive children from those with other disorders and to be sensitive to drug effects. The test is administered through software for the Apple computer. The program presents stimuli consisting of different colored geometric shapes, one at a time. The child is instructed to press the space bar whenever a blue square appears. Errors of omission and errors of

commission were both recorded by the program. A different sequence of stimuli is presented each time, reducing the susceptibility to practice effects. Testing was conducted twice per week with each child for a period of five minutes. At the beginning of each testing session, the tester said, "Remember to push this bar whenever you see a blue square." The tester then started the computer, sat silently as the child completed the test, thanked the child for doing a good job, and returned the child to the classroom. No reinforcement or feedback based on performance was provided.

Paired Associates Learning Test (PAL). This test is commonly used in studies of the effects of stimulant medication and of food additives. Pictures of animals are individually attached to index cards, and the child is asked to learn a number associated with each animal in the set. One trial consists of the presentation of each card in the set. A different set of pictures is used for each session to minimize practice effects. The dependent variable was the number of trials required for the child to teach the criterion of two consecutive trials with no errors. Correct answers were praised. When incorrect the child was told the correct answer and a few additional seconds were provided for the child to look at the card. At the end of each trial, the child was told how many he or she had gotten correct and was encouraged to try to do better on the next trial. Testing was conducted twice weekly requiring 5 to 10 minutes per child.

Abbreviated Connors teacher rating scale. This is a 10-item rating scale for activity level, distractibility, and impulsivity. The teacher notes the degree to which each item describes the child's behavior on a 0 to 3 scale. These values are then totaled, resulting in a possible score of 0 to 30. It was completed twice weekly by one of the teachers after all observations and testing for the day had been completed (Baer, 1987).

The children's behavior was examined under three different conditions, as follows:

Baseline. During baseline, no drinks were served. All measures were conducted as described above.

Caffeinated cola (Diet Coke). Children in this condition received an 8-ounce serving of caffeinated, sugar-free cola each day. The caffeine dosage depended on the child's weight. Sugar-free cola was used to avoid confounding the effects of caffeine with those (if any) of sugar. Measures were conducted as described above.

Caffeine-free, sugar-free cola (caffeine-free Diet Coke). The children in this condition received an 8-ounce serving of caffeine-free, sugar-free cola each day. This condition was included to control for possible effects of being given a drink, regardless of its caffeine content. Although the discriminability of the two beverages was not systematically examined, no indication that the subjects could distinguish one from the other was ever noted (Baer, 1987).

Jan, Ben, and Curt experienced several weeks of the caffeinated cola condition, followed by several weeks of the caffeine-free cola condition, followed by a reversal to the caffeinated cola condition. Meanwhile, Meg, Paul, and Joe experienced several weeks of the caffeine-free cola condition followed by several weeks of the caffeinated cola condition, followed by a reversal to the caffeine-free cola condition. (After 2 weeks in the caffeinated cola condition, Joe complained that the drink was causing stomach pains, and he was returned to a baseline condition at the request of his mother.) (Baer, 1987)

The results of the study are described in the following paragraphs:

Off-task; free play. No relationship between caffeine intake and amount of off-task behavior was observed in any subject.

Off-takk; structured activity. For 5 of the 6 subjects, no relationship between caffeine intake and level of off-task behavior was observed. Caffeine may have been related to a slight increase in off-task behavior in Curt; however, a declining trend in the final caffeinated cola condition makes this conclusion tentative.

Gross motor activity: free play. No relationship between gross motor activity and caffeine intake was observed in any subject.

Actometer readings: structured activities. For Jan and Ben, caffeinated cola may have resulted in a small mean increase in actometer readings. For Meg, caffeinated cola may have resulted in a slight mean decrease. No effect was observed in the other subjects.

Continuous Performance Test (CPT). No relationship between caffeine intake and either type of error on the CPT was observed in any subject.

Paired Associates Learning Test (PAL). For Jan, caffeine intake may have been related to a slight decrease in PAL performance. No relationship between caffeine intake and PAL performance was observed in the other subjects.

Teacher ratings. No consistent relationship between caffeine intake and teacher ratings of hyperactive behaviors was observed in any subject (Baer, 1987).

The results of Baer's (1987) study suggest that caffeine has only small and inconsistent effects on the behavior of young children. The amounts of caffeine used in the study were small, but were consistent with the amounts of caffeine that children of this age are likely to consume, at a single serving, in real-life situations. Some children consume large amounts of caffeine during a day's time. An important question is how much caffeine is in the bloodstream of these children at any one time?

It is possible that the caffeine had effects on behaviors not measured in this study. Important kindergarten classroom behaviors not measured in the study include social behaviors, such as sharing, talking, and playing with peers (Baer 1987).

No restrictions were placed on what the children ate for breakfast. They were served a snack at 10:00 a.m. which usually consisted of unsugared cereal, toast, biscuits, and fruit. Failure to control other aspects of the children's diets could have contributed to the small magnitude and inconsistency of the effects observed. The purpose of Baer's (1987) study was to examine the effects of caffeine when added to the regular diets of the children, because that is what happens in the real world.

This study examined the responses to caffeine of individual children, rather that the effects on groups of children. The study also measured the effects of caffeine repeatedly during each condition. This study did not confound the effects of caffeine with those (if any) of sugar. All the children came from upper middle class families and were considered normal. The children in this study habitually consumed small quantities of caffeine (Baer,1987).

The results of Bear's (1987) study suggest that caffeine may exert some influence on the behavior of preschool children, but these effects are small and inconsistent. Thus restrictions of children's caffeine intake, although possibly wise for medical reasons, probably will have little effect on children's behavior in the classroom.

Since the effects of caffeine are dependent on body weight, the younger the child, the greater the effect. A 12-ounce can of cola may exert the same effect on a child as four cups of coffee do on an

adult (Royster, 1983). The quantities of caffeine that children ingest should be monitored to prevent them from receiving an overdose of the drug.

Sugar

Sugar has often been blamed as the cause of negative behavior, aggressive behavior, and hyperactivity in children. Parents have complained that the day after Halloween little Billy or Sally is climbing the walls. They contribute their child's behavior to the overdose of sugar from consuming too much Halloween candy. As a kindergarten teacher, this author has noticed more restlessness, talkativeness, and aggressive behavior in students the days following Halloween and Easter. The inappropriate behavior usually continues for several days. The behavior could be a result of the excessive amount of sugar ingested when eating the Halloween and Easter candy. Another possibility for the change in behavior may be excitement over the holidays.

Several studies have been performed to determine the effect, if any, of sugar on the behavior of children. One such study was done at the National Institute of Mental Health (NIMH) with 30 boys between the ages of 2- and 6-years-old, for a double blind crossover trial of four different sweeteners. Eighteen of the boys had been classified, by their parents, as "sugar responders." The other 12 boys were playmates; their parents said they had no particular reaction after

Eating sugar. The two groups were similar in mean age, weight, socioeconomic status, and intelligence (Wicklund et al., 1988).

Wicklund (1988) reports that in four challenges, each child received a lemon-flavored carbonated drink containing one of four sweeteners: sucrose, glucose, aspartame (NutraSweet), or saccharin. The drink was given in an NIMH playroom and again two to four days later in the child's home. Challenges were separated by washouts of five to seven days. The child's rate of motor activity was measured by an actometer.

During the playroom challenges, aspartame seemed to cause a slight reduction in motor activity, but no other behavior changes were noted with any of the four sweeteners. In the home challenges, none of the sweeteners seemed to modify activity or aggressiveness in any of the boys. The conclusion is that any effects of the different sweeteners on motor activity and aggression were so subtle that they had little clinical importance (Wicklund et al., 1988).

One theory is that undesirable behavior is the result of low or fluctuating blood glucose levels in some individuals. Lucas (1989) quotes a study which reported that nearly 75% of 261 hyperkinetic children had abnormal glucose tolerance curves following a 5-hour glucose tolerance test. Lack of a control comparison group and controversy regarding glucose tolerance standards in children make this data less conclusive.

A report by Prinz, Roberts, and Hantman suggested that there was a positive correlation between sugar consumption and destructive-aggressive behavior in 4- to 7-year-old hyperkinetic children. This kind of correlation, however, does not imply a causative role for sugar in behavior problems for children (Lucas, 1989).

Compared to correlation studies, sucrose challenge studies have failed to detect significant negative behavioral effects of sucrose. Behar and associates studied sugar and behavior in 21 boys who, according to their parents, responded adversely to sugar. Behavior ratings, motor activity, memory and blood levels were monitored for five hours after a double-blind challenge of glucose, sucrose, or saccharin. These researchers found no significant effect of sugar on any of the behavioral measures in any of these children. The children who consumed sugar were less active and quieter than those given a placebo (Lucas, 1989).

Lucas (1989) discussed another study in which hyperactive boys were challenged with a sucrose or aspartame drink and then evaluated by measures of behavior, motor activity, and cognitive performance. No significant differences were found between the sucrose and the aspartame challenges for any of the tests. Similar studies, including those with preschool children, have reached the same conclusion.

A study at the University of South Carolina to examine the relationship of sugar consumption to behavior in hyperactive and

normal children involved 28 hyperactive children and 26 control children between 3- and 8-years-old. There was no significant difference in the intake of sugar products or in the ratio of sugar products to other nutritional food stuffs in the children's diets. The normal children were found to consume significantly more food in general than the hyperactive children. It was not noted if any of the hyperactive children were on medication at the time of the study (Barkley, 1987).

The results of this study indicate that there appears to be some evidence that high levels of sugar intake may be related to greater amounts of aggressive and restless behavior in hyperactive, but not normal children. The causal direction of this relationship is far from clear and requires much further study. What is clear is that sugar is unlikely to be a major etiology of hyperactivity in children, as the rates of sugar consumption do not appear to differ between hyperactive and normal children (Barkley, (1987).

Low carbohydrate diets are occasionally recommended for hyperactive children. Research has indicated that hyperactive children function better when their carbohydrate intake is regulated. Some of the foods that are not allowed on the low carbohydrate diet include: white bread, colas, sweets, pasta, corn, yams, potatoes, dates, figs, flour, raisins, rice, sweet pickles, sweet yogurt, ice cream, peas, sugar, and meats with fillers. Foods that are allowed include most

fresh vegetables, eggs, meats, spices, artificial sweeteners, salt and pepper, whole grain bread, cheese, dill pickles, and D-Zerta. This list of foods was prepared by the Charles L. Shedd ASPL Research Academy.

All carbohydrates are broken down by the body into glucose (the sugar that is found in the blood) which is the primary source for brain cells. Complex carbohydrates are broken down slowly, so they supply glucose in a gradual manner. Simple carbohydrates enter the bloodstream quickly and may provide glucose too quickly. Brain cells function properly only when the glucose level is maintained within a fairly narrow range. If the glucose level goes too high (for example, after eating a candy bar) or if it drops too low (when a meal is skipped), a carbohydrate-sensitive person nay experience some unpleasant symptoms (A'Hearn).

The carbohydrate-sensitive person functions best on six small meals a day. The meals should be high in protein, moderate in fat, and fairly low in carbohydrates. The carbohydrates eaten should be complex carbohydrates. It is good to replace white flour with whole wheat flour, and restrict or eliminate refined sugar, honey, and other extremely sweet foods (A'Hearn).

An epidemiological study in 1980 has demonstrated that hyperkinetic children ingest no more carbohydrates than do normal children. However, in normal children there is no correlation between carbohydrate intake

and behavioral disorders, but in hyperactive children there is a positive correlation. Investigation of a different sort is required to test whether, in hyperactive children, carbohydrate ingestion results in hyperglycemia or possibly hypoglycemia that may also relate to hyperactivity (Lipton and Mayo, 1983).

A longitudinal study in 1983 by Schoenthaler focused on replacing sugar and junk foods with more nutritious foods in 276 juveniles. He noted over a two year period of time as increase in desirable behavior (Norwood, 1984). Additional problems caused by too much sugar in the diet are discussed later in this paper.

Food Additives

The idea that food additives in the diet can have an effect on children's behavior has become popular. Dr. Benjamin Feingold (1975) was one of the first to bring this theory to the attention of the public. Dr. Feingold was a practicing pediatrician when he became interested in child allergy patients. He joined the Kaiser-Permanente Health Care Program at the Kaiser Research Institute. He became the director of the institute's new Laboratory of Medical Entomology where he developed the Kaiser-Permanente (K-P) Diet. Dr. Feingold became aware that artificial food colors and flavors might be linked with behavioral disturbances in children when he treated a woman who was suffering from acute hives. He placed her on a diet to which she quickly responded. Not only did her hives clear up, her hostile behavior disappeared.

Another problem Dr. Feingold studied was reactions to flea bites which were caused by a low-molecular-weight chemical known as a hapten. This research was extended to aspirin-sensitive patients. Research indicated that a number of foods contained a natural salicylate radical which is not necessarily identical with aspirin but is closely allied on basic structure. Thus, Dr. Feingold designed a patient management program which was termed a "salicylate-free" diet. After 15 years of research foods containing synthetic flavoring and foods that were artificially dyed were added to the list of taboo foods (Feingold, 1975).

Foods containing the aspirin-like radical are: apricots, plums, prunes, peaches, raspberries, grapes, oranges, cucumbers, and tomatoes. Other foods containing natural salicylates include: almonds, apples, blackberries, boysenberries, gooseberries, strawberries, cherries, currants, and nectarines. Some of the foods that are not permitted on the K-P Diet are: cereals that are artificially flavored and/or colored, instant breakfast preparations, manufactured bakery goods, bologna, salami, frankfurters, manufactured ice creams, all manufactured candies, soft drinks, diet drinks, all mint flavored items, condiments, and several more. The list is too long to include all the items (Feingold, 1975).

Children who had previously been labeled hyperactive-learning disabled were referred to Dr. Feingold (1975). Three of the cases

were boys who were 6-, 7-,and 8-years-old. All the boys had been placed on medication to help control their behavior problems. Jonny A was a 6-year-old white male who was physically fine. His mother stated that he was not on medication at that time. Johnny A was placed on rigid food-and-beverage management. His mother kept a strict diet diary of everything he ate or drank. The diary was kept for almost six months. The pattern was definitely one of "turn-on" and "turn-off" by what he ingested. The response might have been a psychological reaction to the diet program and to the constant attention and vigilance of the parents.

Johnny B was an 8-year-old on 20 mgm of Ritalin daily, the initial dosage of 40 mgm had turned him into a "zombie" according to reports. Johnny B's daily meals were loaded with additives, plus a colored, chewable vitamin. Johnny B was placed on the K-P Diet. His mother, after two weeks, reported improvement in behavior as well as an adverse reaction to the Ritalin the last three times he had taken it. Dr. Feingold (1975) wondered if the elimination diet was inducing an intolerance to the drug.

Johnny B's behavior had improved and his school work was improving. The Ritalin was discontinued after several weeks. With absolutely no drug support, the next three weeks were very erratic, both in the classroom and on the playground. His schoolwork continued to improve and home behavior was good (Feingold, 1975).

Johnny B continued to have many problems. The improvement in his school work was an indication that his nervous system was allowing him to concentrate (Feingold, 1975).

Johnny C, a 7-year-old, was taking Ritalin and the tranquilizer Stelazine. The combination of Ritalin and Stelazine had helped to control muscular and nervous movements as well as school behavior, but not, unfortunately, learning ability. A sample food list was filled with artificial colors and flavors. Johnny C was placed on the K-P Diet and after six days his mother reported improvement in behavior. The Ritalin and Stelazine were decreased to once a day after 11 days. The Stelazine was stopped after 15 days, the Ritalin was stopped after 20 days. Johnny C on two occasions ingested foods that were not permitted. The result was hyperactivity (Feingold, 1975).

The K-P Diet is not always successful. Other factors may be present which influence the behavior pattern of the child. Allergies may prevent the K-P Diet from being successful. Some failures are the result of the diet not being followed completely by the parents, or the children refusing to cooperate. Other chemicals, about which little or nothing is known, are involved in some patients--preservatives, possibly, or naturally occurring chemicals (Feingold, 1975).

A study to attempt a more rigorous evaluation of influence of food additives on hyperactive behavior was conducted in 1976 at the University of Pittsburg. This experiment was a double-blind crossover

treatment program comparing a control diet with a diet that eliminated artificial flavors, colors, and naturally occurring salicylates. The study involved 15 hyperactive children who were rated at various times on teacher and parent rating scales. The children were rated during a two-week baseline period while all stimulant medication was withheld and before either of the diets was implemented (Barkley, 1987).

The parents' and teachers; ratings reported fewer hyperactive symptoms while the children were on the experimental diet. The reduction in symptoms was one of approximately 15% from the baseline ratings, with the most dramatic improvement being evidenced in those children who received the control diet first and the Feingold diet second. Only one of the 15 children was actually rated as showing any marked degree of improvement as a result of the Feingold diet (Barkely, 1987).

Sixteen hyperactive children were selected, by the same research group, for a study on the grounds that they had shown previous improvements in behavior in response to the Feingold diet. The children were challenged at various times throughout the course of the study to determine whether the food additives in food worsened their behavior. Three of the 16 children may have shown a deterioration in behavior in response to the food dyes. These children tended to be the youngest among the subjects and tended to show their behavior

changes on the measures of attention span and distractibility within several hours after receiving the challenge. Eight younger subjects who were also previously shown to be diet-responsive were combined with five other children who were considered borderline responders to the diet. The food dyes were noted to have a significant effect on their behavior as rated by parents, the effect was primarily limited to a 3-hour period immediately following ingestion of the food dyes (Barkley, 1987).

Other studies have shown the ingestion of artificial food dyes had negative effects on the subjects. Many studies have found virtually no positive effects of the Feingold diet on hyperactive behavior (Barkley,1987).

A 1978 study evidenced a statistically significant improvement in the mothers' ratings of their children's behavior; however, no statistically significant deterioration occurred in the children's behavior when they were fed the Yellow Dye No. 5, tartrazine. The children in this study had been on the Feingold diet (Johnson, 1981).

In most studies there are findings suggesting a scarcely significant relationship between diet and behavior, particularly among young or hyperactive children. The task now is to identify the small subpopulation of hyperactive children who can profit from a therapeutic diet (Johnson, 1981).

Because the challenge studies are simpler to perform, 190 children

were subjects in seven different independent studies. In no instance was there consistent dramatic deterioration in behavior following challenge with artificial food colors under double-blind conditions. Three children were exceptions to these findings. In the three cases, deterioration in behavior following the food diet was reported only by the mothers, with no objective confirming evidence available (Lipton and Mayo, 1983).

Seelye (1986) noticed that her child's behavior began deteriorating. She was difficult to control, unpleasant, and abusive at times. The child had a persistent thirst. She drank orange squash, a British drink similar to Kool-Aid in the United States. The inappropriate behavior was noticeable after consumption of the orange squash as well as after the consumption of a favorite snack food. Examination of ingredients revealed that both the snack food and the orange squash contained one common ingredient, the artificial coloring E102. The snack food and the orange squash were excluded from the child's diet. Finally all products containing E102 were excluded from the child's diet at home. Five weeks later the child' behavior was once again acceptable. Seelye thinks the child was addicted to the E102 because she had to have more and more.

Artificial colors and flavors are widespread in our food supply. Of some 2800 intentional additives used in foods, approximately 2100 are flavorings and 33 are colors, most of which are synthetic. Two

specific substances cause adverse physical reactions in susceptible individuals. These are monosodium glutamate, and tartrazine, which causes allergic response in persons who are also sensitive to aspirin (Lucas, 1989).

Additive free diets may be occasionally efficacious in the control of childhood hyperactivity; but they clearly do not, as originally claimed, aid the majority of hyperactive children (Mailman andLewis, 1983).

Food Allergies

Food allergies have been associated to children's behavior. "More specifically, many researchers and practitioners are addressing the role allergies play in aggression, schizophrenia, psychosis, hyperactivity, and other childhood abnormalities. In fact, reports in the literature during the past 60 years indicate that allergy may be an important factor in many behavioral and neurological syndromes," quote Vass and Rasmussen, 1984).

Crook in 1980 presented results of a study in which he surveyed parents of hyperactive children. Most of the parents he surveyed reported that their child's hyperactivity was related to specific foods in the diet. Crook's conclusion was: "Based on reports that have appeared in the literature during the last 60 years and my own clinical experience, I am absolutely certain that what a child eats can make him dull, stupid, and hyperactive." (Vass and Rasmussen, 1984)

Because the brain is just as vulnerable as any other part of the body to the ravages of allergy, any child demonstrating learning, behavioral, or neurological disturbances of a chronic or recurring nature should be evaluated for the possibility of allergy. Such problems may be indicated by low achievement test scores, especially if intelligence test scores are significantly higher. Behavior problems observed by teachers, parents, or counselors may be suggestive of a potential allergy and may need more specific evaluation (Vass and Rasmussen, 1984).

Dr. Richard H. Stout, an allergy specialist in Murray, Kentucky, states that it is difficult to make a proper diagnosis of food allergy because there is no reliable test for food allergy other than elimination of the food and a subsequent challenge with it.

Foods are not the only environmental factors implicated in allergy. Various chemicals commonly found in home or school environments may contribute to allergy problems (Vass and Rasmussen, 1984). The summation effect is another possibility. A child could possibly be able to eat chocolate year round without any symptoms, and also go through ragweed season without any symptoms, but might have severe sumptoms if he ate chocolate during ragweed season. Some children with symptoms of food allergy due to milk, corn, wheat, or other foods may improve in the summer months when their exposure to house dust is less. The most common offending foods in order of occurrence

are: peanut, chocolate, milk, soybean, egg, wheat, chicken, corn, orange, beef, potato, pork, and oats (Stout).

It is necessary in diagnosing allergy to determine a cause and effect relationship between exposure to a cretain food and the appearance of symptoms, or, conversely, the absence of symptoms in the absence of the exposure. In some cases, the parents may be able to find the source by keeping a complete diary, listing everything the child eats, when it is eaten, and all physical and behavioral complaints (Vass and Rasmussen, 1984).

General Nutrition

Good nutrition does have an effect on children"s behavior, learning abilities, and social relationships. Children who do not eat foods that are considered nutritious generally do not feel as well or perform as well in school as do children who have nutritious diets.

A review of nutrition and school performance studies over several decades suggest that children who go to school without breakfast are likely to be more lethargic, inattentive, and irritable, but there has been no strong documentation to support this association. A study of 9- to 11-year old children in a laboratory setting measured problem solving, memory, and attentiveness after the children had eaten or not eaten breakfast. Although blood glucose levels were not significantly different between children fed or

not fed, other biochemical parameters suggested a meatbolic stress on those without breakfast. The children who fasted made more errors in the problem-solving task but performed better on short memory recall (Lucas, 1989).

A similar study assessed these same cognitive abilities throughout the morning in same age children who received or did not receive breakfast. The fasting children made more errors and had a more variable performance on a continuous performance task over the course of the morning than children who had breakfast. Although these results show that brief fasting has an impact on cognitive functioning, the degree to which skipping breakfast alone affects behavior or school performance is unclear (Lucas, 1989).

Breakfast provides energy in the morning hours that is necessary to the body functioning properly. Research conducted by the State University of Iowa concluded the individual who eats an adequate breakfast is quicker in actions and can learn more during the late morning hours. Nutritionists believe the breakfast diet should provide one-fourth to one-third of the daily food intake (Norwood, 1984).

Iron deficient anemia is a common name for decreased hemoglobin levels in the body. Iron is necessary to carry oxygen to the brain and other parts of the body. Often a child who has deficient levels of iron available has been labeled a slow learner and experiences

a low level of performance. The child may appear lazy, easily tired, and sometimes dizzy (Norwood, 1984)

Iron deficiency is the most common nutrient deficiency. It has long been implicated in negative changes in behavior and performance. Researchers have found that compared with controls, preschool children with iron deficiency with or without anemia are less likely to pay attention to relevant cues in problem-solving situations. This information has clinical implications in terms of assessing the overall nutrient quality of the diet of a "behavior problem" child (Lucas, 1989).

Protein deficiency is another problem area in the diets of some children. Whenever a protein deficiency is evidenced, the development of the individual's nervous system and brain are impaired. Children with protein deficiencies have less ability to learn, have lower IQ's, and have poorer language development than children with sufficient protein diets (Norwood, 1984).

Sugar excesses in the body may cause additional health problems beyond those associated with hyperkinetic conditions. As the sugar intake rises, total caloric intake rises, which could result in obesity. Social and emotional development may decline and physical activity may decrease if a child becomes obese. Lower self esteem may be created by an undesirable body, a lack of friends may occur, and a negative change in the learning process could be the end result (Norwood, 1984).

Hunger is a growing problem across America. Hunger prevents

children from performing effectively in concentration activities. Often these children are perceived as tired, bored, listless, and/or apathetic. Children who come to school hungry concentrate more on being hungry than the learning activities they are supposed to doing (Norwood, 1984).

A relatively new research focus has been the relationships between nutrition, the brain, and behavior. The influence of dietary components on the synthesis of the brain neurotransmitters, which in turn affect behaviors such as appetite, mood, and depression are being studied. Results indicate that lethargy and sleepiness increased and mental alertness was lower after a high-carbohydrate rather than a high-protein lunch (Lucas, 1989)

Nutritional deficiencies do relate to learning difficulties in children. Children must have a well-balanced daily diet in order to perform well in school. The diet should consist of a variety of foods including fruits, vegetables, grains, dairy products, and meats.

Conclusion

This author believes that food products can have a negative effect on some children, normal children as well as hyperactive children, some of the time. The nutritional effect of food products affects all children. All children must receive a well-balanced diet to function well in the classroom and social settings. Children who eat well-balanced diets feel well in general.

Research results have been contradictory. More studies, such as the study Baer did with preschool children, need to be done Studies performed in the children's natural surroundings should prove to be more beneficial than studies of children that are performed in unfamiliar surroundings. Studies should be done to learn whether or not food products have behavioral effects on normal children. Most of the studies have been centered on hyperactive children. The effects of combinations of food products should also be researched.

Recommendations

Teachers who suspect certain negative behaviors may be related to diet should discuss the problem with the parents. If there is a pattern of behavior/food relationship, suggestions that the suspected offending foods be eliminated from the diet would be in order.

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